

Chapter Six

Conclusions and Future Work

In high-density power supply designs, electrical, thermal, and EMC performances have become very important and integral aspects. This work addresses the following critical areas: the efficiency improvement of using synchronous rectification in both forward and flyback converters, the design of converter paralleling, the optimization of the thermal management for converters in sealed enclosures, and the minimization of the conducted EMI noises.

The efficiency improvements of synchronous rectification over conventional diode rectification are derived for forward and flyback converters. The performance of the synchronous rectifiers in forward converters depends on their driving method and the power transformer reset method. For self-driven SRs, reset methods that provide full dead-time driving signals are desirable. For control-driven SRs, the timing of the driving signals is critical. The performance of the synchronous rectifier in flyback converters depends on the converter operation modes and the PWM control schemes. The CCM flyback converter has the highest efficiency for high-

current applications, while the VF DCM and ZVS DCM flyback converters outperform the CCM and CF DCM converters for low-current applications.

Converter paralleling for high-density, low-profile, high-power applications has been analyzed. Transformer paralleling requires even current sharing, which can be provided by using separate forward diodes and common heatsinks. The two-choke interleaved forward converter has the advantage of ripple current cancellation, while the one-choke interleaved forward converter has the advantage of simpler structure at the expense of a lower conversion efficiency.

The optimization of the thermal management of high-density power converters in sealed enclosures is realized using 3D FDA computer-aided simulations. Power-density limit is derived analytically for applications which rely on natural convection and radiation. Uniform internal heat distribution is desirable to maximally utilize all the available heat removal mechanisms. Using RM transformers, TO220AB MOSFETs, and surface heat-spreader are found to help reducing the enclosure surface temperature and component temperatures.

A systematic approach to predicting and analyzing conducted EMI noise is developed and illustrated. The procedure includes the steps such as parasitics extraction for layout and packaging, circuit component and measurement setup modeling, EMI filter design, and EMI performance simulation. The theoretical design and noise predictions are verified experimentally and yields good agreements with the measurement data.

The electrical, thermal, and EMI design aspects can be integrated at the system-level design for an overall performance optimization, as shown in Fig. 6.1, and would be of the interest to future research efforts. Software packages can be used for each design block to

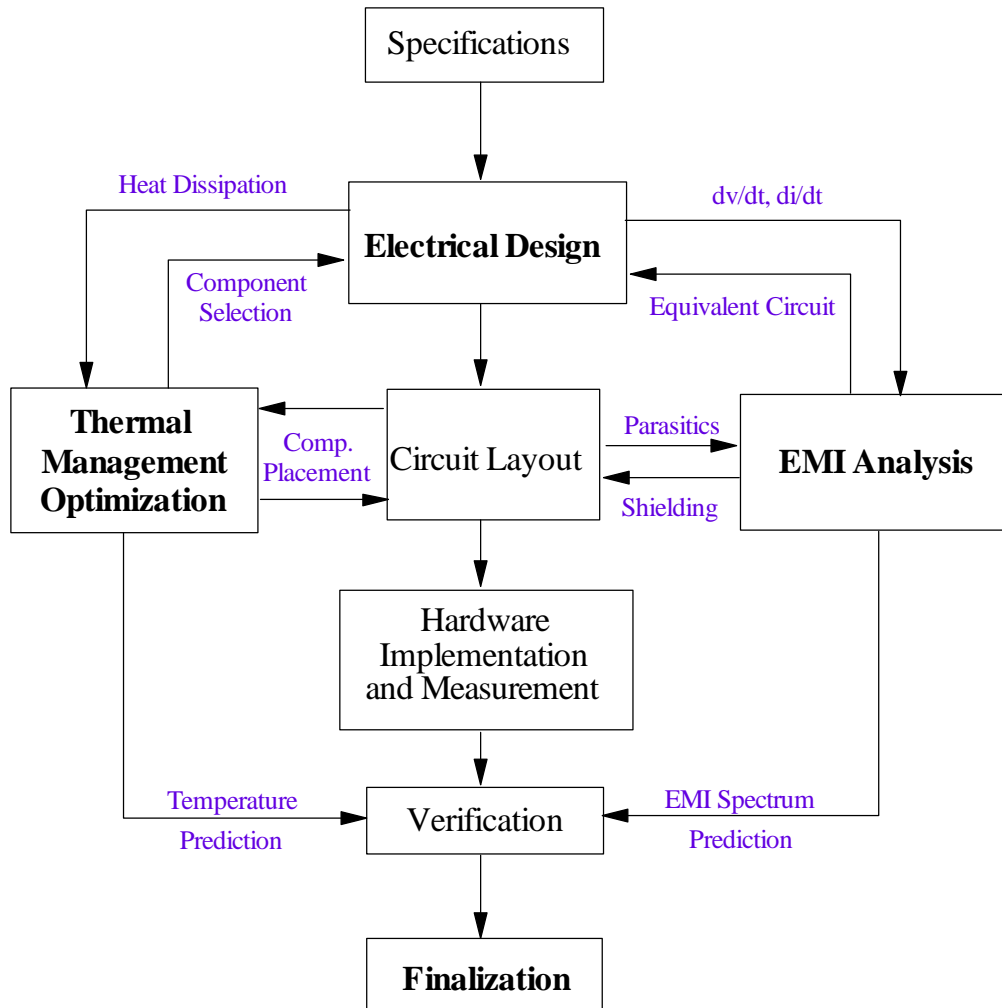


Figure 6.1. A concurrent approach to high-density power supply design.

optimize the specific performance. At the system level, an algorithm needs to be developed to integrate the electrical, thermal and EMI analysis, and coordinate the interaction between different design blocks for a system-level optimization using an iterative method. After reaching a satisfactory solution or an optimized design, the simulation results will be experimentally verified.

Furthermore, the following topics are of considerable research interest for future work:

- The EMI performance comparisons of hard-switched flyback converter and soft-switched flyback converter with synchronous rectifier (no auxiliary circuit).
- The layout and packaging designs for thermal and EMI performance optimization.
- The impact on EMI of soft-switching vs. hard-switching